

Contractor's Report to the Board

The Feasibility, Constructability, and Efficacy of Tire-Derived Aggregate as a Component in Slurry Cutoff Walls

***Produced under contract by:
CSU, Chico Research Foundation***

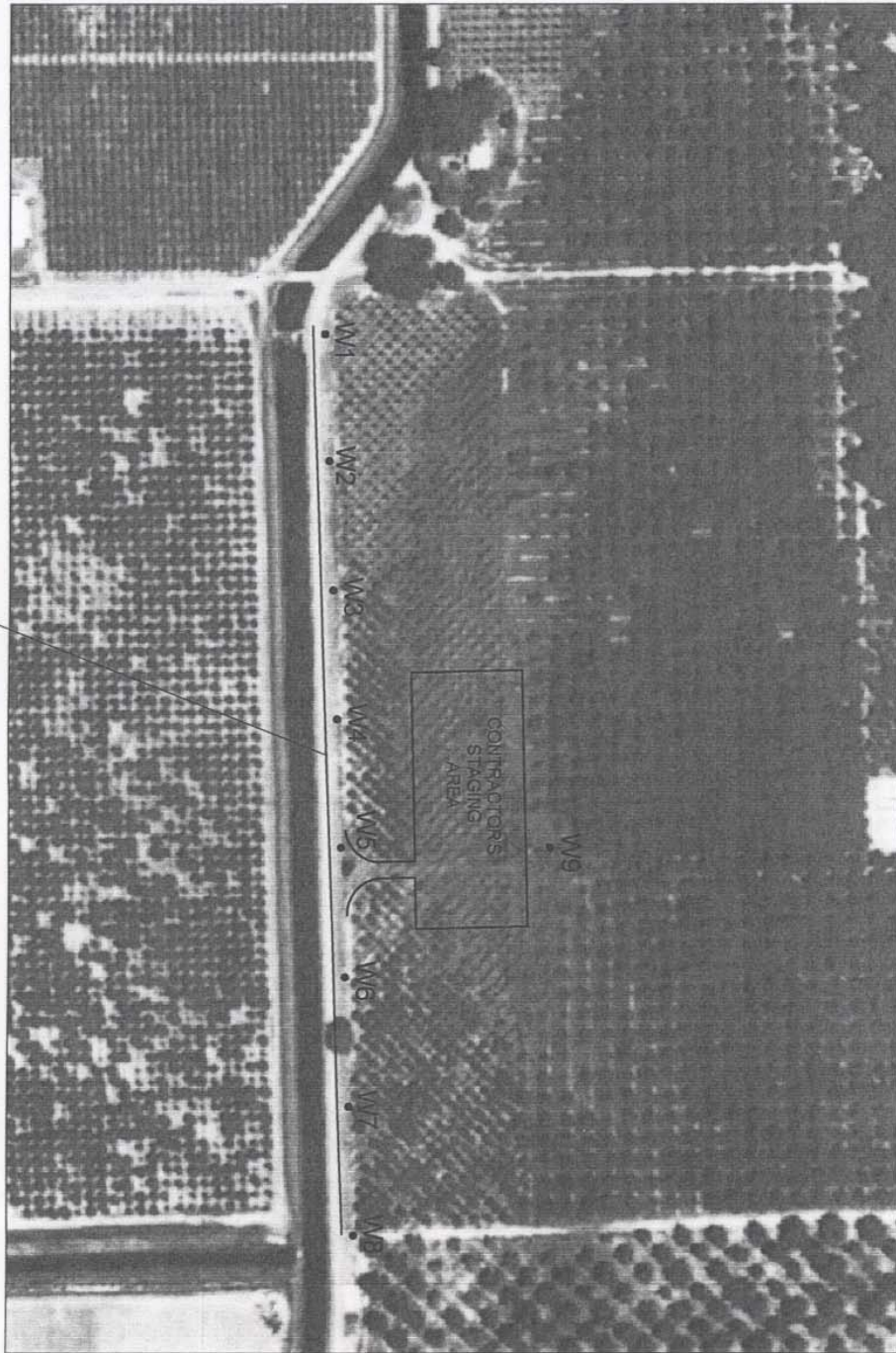


June 2006

Appendices A–C

Appendix A

Project Plans



CUTOFF WALL

SHEET
1
OF 1 SHEETS



RECYCLED TIRE CUTOFF WALL DEMONSTRATION PROJECT

The California Integrated Waste Management Board
The Research Foundation at California State University, Chico

Appendix B

Project Specifications

SECTION 02330

SLURRY CUTOFF WALL

1. **SCOPE:** The work covered by this section of the specifications consists of furnishing all plant, labor, equipment, and materials and of performing all operations in connection with the construction of a slurry cutoff wall, in accordance with these specifications and applicable drawings. Shredded rubber for backfill to be supplied by California State University Research Foundation.

2. **APPLICABLE PUBLICATIONS:** The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent referenced.

2.1 American Petroleum Institute (API) Standard Specifications:

API RP 13B-1 (1990; 1st Ed) Recommended Practice Standard Procedure for
Field Testing Water-Based Drilling Fluids

API SPEC 13A (1993; 15th Ed) Specification for Drilling-Fluid Materials

2.2 American Society for Testing and Materials (ASTM Standards):

ASTM C 143 (1990a) Slump of Hydraulic Cement Concrete

ASTM C 150 (1994) Standard Specification for Portland Cement

ASTM D 422 (1994) Standard Test Method for Particle Size Analysis of Soils

ASTM D 2487 (1994) Standard Classification of Soils for Engineering Purposes

ASTM D 4318 (1993) Standard Test Method for Liquid Limit, Plastic Limit, and
Plasticity Index of Soils

ASTM D 698 (1991) Laboratory Compaction Characteristics

ASTM D 1556 (1990) Standard Test Method for Density and Unit Weight of Soil
in Place by the Sand-Cone Method

ASTM D 4832 (1988) Preparation and Testing of Soil-Cement Slurry
Test Cylinders

2.3 U.S. Army Corps of Engineers Publications:

EM 1110-2-1906 (1970) Laboratory Soils Testing
Appendix VII

3. GEOTECHNICAL SITE CONDITIONS:

3.1 Exploration Borings: Subsurface exploratory borings have been obtained by the California State University Research Foundation. Logs of explorations are included in the contract documents. The borings show the subsurface soil conditions and groundwater encountered at the time of drilling.

3.2 It is the Contractor's responsibility to become acquainted and satisfied as to the character, quality, and quantity of surface and subsurface materials by inspecting the sites and by evaluating information derived from the exploratory work that may have been accomplished by others or included in these Contract Drawings. Any failure by the Contractor to become acquainted with all the available information will not relieve him from responsibility for properly estimating the difficulty or cost of successfully performing the work.

4 DEFINITIONS: The terms used in this section are defined as follows;

4.1 Slurry Cutoff Wall: The slurry cutoff wall is a 1.5-foot minimum width barrier installed below the prepared working surface using the slurry trench excavation method and backfilled with the approved slurry cutoff wall backfill as defined below, and capped with compacted fill as defined in subparagraph "Slurry Cutoff Wall Cap," to form a relatively impervious cutoff wall.

4.2 Slurry Cutoff Wall Cap: The cap is a gradually widened transition zone of compacted fill placed between the top of the slurry cutoff wall and the base of the pavement section.

4.3 Slurry: Slurry is a colloidal mixture of bentonite (fully hydrated) and water or other suitable material approved by the California State University Research Foundation Representative.

4.4 Bentonite: Bentonite is an ultrafine natural clay whose principal constituent is sodium cation montmorillonite.

4.5 Slurry Cutoff Wall Backfill: A homogeneous mixture of material produced by mixing soil, bentonite, cement, shredded rubber tires and water and/or other materials approved by the California State University Research Foundation Representative which is used to construct the slurry cutoff wall below the cap.

4.6 Groundwater Level: The groundwater level is the piezometric level of the groundwater as determined from piezometers and wells. There have been no wells installed for this project. The groundwater shown on the drill logs were groundwater levels at the time of drilling. The groundwater level can vary depending on river stage and season.

4.7 Working Surface: The working surface is the top of the prepared surface on the levee and as shown on the drawings.

5. **SUBMITTALS**: In accordance with SECTION 1305, SUBMITTAL PROCEDURES, the Contractor shall submit data for approval by the California State University Research Foundation Representative for the following items required by this section prior to the start of work unless otherwise indicated herein.

5.1 Schedule and Sequence of Operations: The schedule and sequence of operations shall include but are not limited to use of excavated material, waste management, slurry preparation, slurry placement, bottom cleaning, and backfill preparation and placement.

5.2 Slurry Trench Construction: The layout of operations for the construction of the slurry trench shall include but is not limited to drawings depicting the bentonite storage area, slurry preparation area, hydration ponds(s) slurry storage area, backfill storage and mixing area, location and sizes of all stationary equipment, water storage tanks, pumps, valves, lines, hoses, materials, and waste areas.

5.3 Equipment: Data on equipment to be used in the construction of the slurry trench and equipment to be used in the Contractor's quality control testing.

5.4 Bentonite certification

5.5 Cement certification

5.6 Backfill Mix Design Test Procedures

5.6.1 General: A design mix will be supplied to the contractor. The California State University Research Foundation reserves the right to modify the backfill mix design as required to meet hydraulic conductivity (permeability), compressive strength, and slump. The bid should be based on the following mix:

Component	% of Dry Wt.
Soil	67
Bentonite	3
Cement	5
Tire chips	25

5.6.2 This section not used.

5.6.3 This section not used.

5.6. This section not used.

5.6.5 This section not used.

5.6.6 Basis for Selection of the Backfill Mix Design:

This section not used.

5.7 Quality Control Testing Equipment and Procedures: The Contractor will submit for approval the methods to be used during construction for assuring the constituents of the approved backfill mix design properties, and bentonite slurry are continually met. This includes equipment and procedures for slump, and verifying the mix proportions of the soil, bentonite, cement, water, and any other approved constituents of the mix design are continually met.

6. MATERIALS:

6.1 General: The Contractor shall maintain at the jobsite a sufficient quantity of raw materials and other supplies such that the work can proceed uninterrupted by material shortages. The slurry and slurry wall backfill to be used shall be suitable for the project. The Contractor shall use the approved cutoff wall backfill design mix supplied by the California State University Research Foundation Representative.

6.2 Bentonite: The bentonite shall be a sodium cation base montmorillonite powder (Premium Grade Wyoming-type bentonite) that conforms to the standards set forth in API SPEC 13A, Section 4. The Contractor shall furnish to the California State University Research Foundation Representative a

certificate of compliance and a copy of the test reports from the bentonite manufacturer for each lot of bentonite shipped to the site stating that the bentonite complies with all applicable standards. No bentonite from the bentonite manufacturer shall be used prior to acceptance by the California State University Research Foundation Representative. All bentonite will be subject to inspection, sampling, and verification of quality by testing under the supervision of the California State University Research Foundation. Bentonite not meeting the specifications shall be promptly removed from the site and replaced with bentonite conforming to specification requirements at the Contractor's expense. Bentonite shall be protected from moisture during transit and storage.

6.3 Cement: Cement shall be Portland Cement Type I or Type II (per ASTM C 150). A written certification specifying cement quality shall be provided by the cement supplier and retained by the Contractor.

6.4 Water: The Contractor shall supply all water required for mixing with bentonite to produce slurry and slurry backfill. The water shall be clean, fresh, and comply with the standards set below:

- a. A pH equal to 7.0 plus or minus 1.0.
- b. Total dissolved solids not greater than 500 parts per million.
- c. Oil, organics, acids, alkali, or other deleterious substances not greater than 50 parts per million each.
- d. Hardness less than or equal to 50 ppm (Recommendation Only).

The canal at the work site is an acceptable source of water.

6.5 Admixtures: In the event the Contractor uses any additional admixture, it shall be subject to approval of the California State University Research Foundation Representative and the Contractor shall have on file a written statement as to the use of any such admixture, its effect on the slurry, its long-term stability, and its effect on the environment. Admixtures of the type used in the control of oil field drilling mud such as thinners, dispersants, and flocculants may be used to control standard properties of the slurry such as apparent viscosity and filtration characteristics subject to the approval of the California State University Research Foundation Representative. Peptizing or bulking agents shall not be mixed with the slurry.

6.6 Shredded Rubber Tire: Shredded Rubber tire will be supplied by the California State University Research Foundation. The approximate size of the tire chips will be capable of passing a 2" sieve. The tire chips will be delivered to the jobsite staging area by the tire processor. The haul vehicle will be an end dump truck.

6.7 Bentonite Slurry: The bentonite slurry for supporting the sides of the trench and that mixed with the backfill shall consist of a stable colloidal suspension of powdered, premium-grade natural bentonite in water. It is the responsibility of the Contractor that the slurry meets the necessary properties. The properties of the slurry used in all construction sequences shall be determined in accordance with the testing procedures described in API RP 13B-1 and shall conform to the following requirements:

6.7.1 Initial Bentonite Slurry Mixture: At the time of introducing bentonite slurry into the trench excavation, the slurry mixture shall have a minimum apparent viscosity of 40 seconds as measured by the Marsh funnel. The slurry density shall be a minimum of 64 pounds per cubic foot. The water loss shall not be greater than 20 cubic centimeters in 30 minutes as measured by a filter press at 100 psi. Mixture adjustments shall conform to the requirements in paragraph "ADDITIONAL BENTONITE."

6.7.2 Trench Bentonite Slurry Mixture: The minimum apparent viscosity of the bentonite slurry mixture in the trench at any time shall be 40 seconds as measured by the Marsh funnel. The density of the slurry in the trench at any level shall be between 64 and 85 pounds per cubic foot. The water loss shall not be greater than 20 cubic centimeters in 30 minutes as measured by the filter press at 100 psi. Mixture adjustment shall conform to the requirements in paragraph "ADDITIONAL BENTONITE."

6.7.3 Additional Bentonite: If directed by the California State University Research Foundation Representative, the Contractor shall thicken the slurry to a more viscous condition than the limits specified above. The Contractor shall use additional bentonite, as directed.

6.8 Soil: Soils obtained from the cutoff wall construction, imported material, or combination thereof, for use in the slurry cutoff wall backfill, shall contain no material sizes larger than 3 inches in diameter and shall be free of roots, debris, and other deleterious material that may adversely affect the properties of the backfill. The Contractor is responsible for changes in the chemistry of soils used in the slurry wall cutoff construction and its effect on the desired properties of the backfill.

6.9 Slurry Wall Backfill: The slurry wall backfill mix shall conform to the design as stated in Section 5.6.1. However the California State University Research Foundation and contractor will cooperate in modifying the mix, if necessary, to improve workability. The Intent of the Research Foundation is to verify the viability of a mix incorporating waste tire chips. The goal is for the mix to meet permeability and strength requirements while maximizing the quantity of tire chips used. All backfill shall be free of roots and other deleterious materials.

6.9.1 Testing: The backfill mix will be sampled at least every 300 ft. of wall or when any changes are made to the backfill mixing operation. The California State University Research Foundation will be responsible for all testing of the backfill mix. Plastic molds shall be used to cast the mix specimens. The molds will be twelve-inch diameter by twelve -inch long test cylinders for permeability tests and twelve-inch diameter by twenty-four-inch long test cylinders for strength tests. The wet samples will be poured into the molds and rodded or vibrated to remove trapped air pockets and then sealed. The specimens will be stored in a constant temperature, damp environment, positioned on porous stones with filter paper to allow for drainage during the curing period, until tested or otherwise directed by the California State University Research Foundation Representative.

6.9.1.1 Compressive Strength Testing: Two test specimens from each sampled batch will be subjected to unconfined compressive strength testing (ASTM D4832-88). One of the samples will be tested after curing for fourteen (14) days, and one after curing for twenty-eight (28) days.

6.9.1.2 Permeability Testing: One test specimen from each sampled batch will be subjected to permeability testing. The sample will be tested in accordance with the requirements prescribed in EM1110-2-1906, Appendix VII, Back Pressure Method.

The permeability test parameters to be used are as follows:

- Average Effective Confining Stress: 10 psi
- Hydraulic Gradient: 15
- Permeate: Canal water near the site
- Backpressure: Sufficient to ensure a Skempton's pore pressure "B" parameter greater than or equal to 0.95.

Permeability tests will be performed on the same sample after 14 days and 28 days.

6.9.2 Basis for Selection of the Backfill Mix Design: The mix design has been selected based on the results of the a trial mix design program performed by California State University Research Foundation. The following parameters have been used as the basis for the selection of the mix design.

Permeability (28-day)	5X10 ⁻⁷ cm/sec (maximum)
Compressive Strength (28-day):	15 psi (minimum)
	200 psi (maximum)
Slump	4 to 6 inches

6.10 Material Storage Facilities: The Contractor shall provide all necessary materials, equipment and personnel to store bentonite, cement and other additives under conditions to prevent moisture or other contaminants from mixing with the materials prior to use in the slurry plant.

7. **EQUIPMENT:**

7.1 General: The Contractor shall furnish all necessary plant and equipment for efficiently stripping, cutting, and/or filling to form the slurry-mixing and equipment-operating surface; excavating the trench; mixing and placement of backfill; disposal of undesirable excavated material in accordance with other provisions of this contract; and, preparation for and placement of the impervious cap on the completed trench, and for testing of the materials used in such process. The Contractor shall obtain and maintain at the jobsite a supply of spare critical replacement parts or backup equipment sufficient to allow the slurry cutoff wall construction to proceed with minimum loss of time due to mechanical breakdown or equipment failure.

7.2 Equipment Weight, Speed, and Width: Weight of equipment to be used on the levee crown shall be limited to a maximum gross loaded axle weight of 16,000 pounds, and a maximum track vehicle weight of 2,500 pounds per square foot. The maximum operating speed of all equipment used on

the levee crown roads shall be 15 mph. The maximum overall width of equipment used on the levee shall be limited to 18 feet.

7.3 Cutoff Wall Construction: Trench excavation equipment for excavating the slurry trench shall be any type of earth moving machinery capable of performing the indicated work on the drawings and/or as specified herein. The equipment shall be that which reduces live-load surcharge to a level that will produce no significant contribution to the instability of the trench. Regardless of the equipment type used, it shall be capable of excavating to the required depth and width of the trench in a single pass of the excavating equipment. If a dragline bucket is used, it shall be a heavy duty model with no protrusions along the sides of the bucket for drag or hoist chains extending beyond the limits of the cutter teeth.

7.4 Mixing and Delivering Slurry: Slurry mixing and placing equipment will be approved by the California State University Research Foundation Representative. The slurry mixing plant shall be a colloidal batch or continuous mixing plant. It shall include the necessary equipment, including a mixer capable of producing a stable colloidal suspension of slurry or other mix combinations approved by the California State University Research Foundation Representative. It shall include pumps, valves, hoses, supply lines, tools, and other equipment and materials required to adequately supply slurry to the slurry trench. Tanks for storage of hydrated slurry shall be mechanically or hydraulically agitated.

7.5 Mixing and Placing Backfill: The equipment used for the mixing and placing of the backfill material, including but not limited to bulldozers, disks, harrows, motor patrols, pugmills and haul trucks shall be capable of mixing backfill materials into a homogeneous mixture conforming to the contract requirements and be suitable for placement of the backfill material in the trench as specified herein. Initial placement of backfill on the trench bottom shall be by clamshell or other approved method and shall prevent free fall, segregation, and entrapment of slurry.

7.6 Retaining Berms: Suitable grading and earth-moving equipment shall be available for preparing the work area for slurry cutoff wall installation including equipment for the construction of slurry spill retainment berms or ditches.

7.7 Hauling Equipment: Hauling equipment shall consist of pneumatic-tired vehicles having dump bodies suitable for dumping.

7.8 Cleaning of Slurry: Slurry cleaning equipment shall include but not be limited to a vibrating shaker screen, centrifugal sand separator, and/or stilling ponds.

8.0 LEVEE PREPARATION:

8.1 The Contractor shall prepare the working surface of the levee section to a firm and essentially level condition for passage of the Contractor's machinery and equipment as shown on the drawings. A berm or other appropriate type of barrier shall be constructed to prevent off-site movement of waste materials, slurry spills, etc.

8.2 The Contractor shall provide, install, and maintain all layout and necessary construction staking to locate the cutoff wall within the Range of Allowable Cutoff Wall Installation shown on the contract drawings. The contractor shall submit a staking plan which identifies the station and location to provide accurate locations and to ensure that the levee elevation is returned to its current elevation. A system for locating stations along the cutoff wall alignment and relating them to the plans shall be established by the Contractor and submitted to the California State University Research Foundation Representative for approval.

9.0 SLURRY CUTOFF WALL CONSTRUCTION:

9.1 General: The slurry cutoff wall as placed shall be homogeneous and shall be constructed to the elevations, lines, grades, and cross-section shown on the drawings and in accordance with these specifications, unless otherwise directed by the California State University Research Foundation Representative. The slurry cutoff wall shall be constructed to the following dimensions using the approved backfill mix design and procedures:

Width:	18-inch minimum
Depth:	28 feet below crown of levee
Mix Design:	As supplied by the California State University Research Foundation

Representative (See Paragraph 5.7.1- BASIS FOR SELECTION OF THE BACKFILL MIX DESIGN)

Final acceptance of the cutoff wall will be based on quality control testing of the backfill material. Any installed material not in compliance with the accepted backfill mix design shall be removed and replaced by the Contractor at his own expense. The California State University Research Foundation may modify the dimensions and quantities of the work as determined necessary. The Contractor shall submit a general work sequence schedule and layout plan of operations to the California State University Research Foundation Representative for approval ASAP after contract award and a minimum of 3 calendar days prior to the start of construction.

9.2 Working Surface: The working surface from which the slurry cutoff wall is to be constructed shall be as defined in paragraph "DEFINITIONS," and shall constitute the top of the slurry cutoff wall cap for the purpose of measurement for payment. However, the Contractor may construct, at no additional expense to the California State University Research Foundation, a working surface to a level no more than eighteen (18) inches lower than the existing levee crown for his own convenience. There will be no payment for any additional excavation, fill, relocation, or slurry cutoff wall required as the result of

constructing a lower level working surface than the defined working surface. Upon completion of the slurry cutoff wall installation, the levee shall be restored to final alignment and grade. Material excavated for the purpose of constructing a lower working surface may be reused to replace the top of the levee. The compaction and testing requirements for the replaced levee material shall be the same as described in paragraph "SLURRY CUTOFF WALL CAP." The Slurry Cutoff Wall Cap shall then be constructed as described in paragraph "SLURRY CUTOFF WALL CAP."

9.3 Blasting: Explosives shall not be used in connection with this contract.

9.4 Excavation: The excavation shall be by the slurry method. Excavation shall be conducted in a manner which provides for a continuous 1.5-foot minimum width trench to the required depth at all points along the centerline of the excavation. The Contractor shall excavate the slurry trench from the working surface. The excavation shall be carried immediately to the minimum depth shown on the drawings at the point where excavation is started. The California State University Research Foundation Representative may direct the Contractor to deepen the trench based on examination of the bucket cuttings. The toe of the slope of the trench excavation shall not precede the toe of the backfill slope by less than 50 feet or more than 150 feet. The slurry trench shall be constructed without undue interruption until complete. If extended delays in backfill operation occurs for any reason, the California State University Research Foundation Representative may require reexcavation of the placed backfill. If required, this reexcavation shall consist of the removal of 5 feet perpendicular to the slope of the backfill for the full depth of the slurry trench. That section of the slurry trench backfill material that is removed and rebackfilled shall be considered incidental to the slurry trench cutoff pay item.

9.5 Placement of Slurry: The slurry shall be introduced into the trench at the time excavation begins. The level of the slurry in open trenches shall be at all times maintained a minimum of 2 feet above the groundwater level and between 6 and 18 inches below the working surface until the placement of backfill material is complete. The Contractor shall have sufficient personnel, equipment, slurry storage areas, and stored slurry materials ready to raise the slurry level at all times in the excavated trench during construction within the limitations specified in paragraph "SLURRY CUTOFF WALL CONSTRUCTION" and subparagraphs thereof. To this end, the Contractor shall have personnel on call to raise the slurry level at any time this occurs, weekends and /or holidays included. Dilution of the slurry by surface waters shall be prevented. The quality of the slurry shall be maintained at all times, including periods of work stoppage, in a condition which meets the requirements set forth in paragraph "BENTONITE SLURRY." Conditioning of the slurry may require recirculation through shaker screens or the addition of approved additives.

9.6 Excavated Material: Material excavated from the trench meeting the requirements of paragraph 6.8 Soil, may be used in the backfill. Material not used in the backfill shall become the property of the Owner. Contractor to evenly spread excess soil over the contractors laydown area as directed by the California State University Foundation Representative.

9.7 Stability: The Contractor shall be responsible for insuring and maintaining the stability of the excavated trench at all times for its full length and depth and shall be responsible for maintaining slurry densities and levels within specified limits. The Contractor shall control surcharges from all excavation and backfilling equipment, waste, berm construction, backfill stockpiles, and any other loading situations that may affect trench stability. It is the Contractor's sole responsibility to ensure that the mixing of backfill and any stockpiles do not affect the open trench stability. In the event of failure of the trench walls prior to

completion of backfilling, the Contractor shall at his expense reexcavate the trench and remove all material displaced into the trench and take corrective action to prevent further deterioration.

10. BACKFILLING:

10.1 Mixing Areas: Areas for mixing of backfill, preparing compacted fill for the slurry cutoff wall cap, and other operations shall be located within designated staging areas shown on the contract drawings or within areas approved by the California State University Research Foundation Representative. All mixing areas shall be cleaned up and restored upon completion of the work in accordance with paragraph "CLEANUP."

10.2 Mixing: Stockpiled material generated during slurry cutoff wall installation and/or material from borrow or commercial sources shall be mixed and blended by approved methods. The backfill material shall be thoroughly mixed into a homogeneous mass, free from large lumps or pockets of fines, sand, or gravel. Occasional lumps of up to four (4) inches in their largest dimension will be permitted. The backfill material shall have a consistency as approved by the California State University Research Foundation Representative. The backfill material, just prior to placement in the trench, shall have a consistency to provide a slump of from 4 to 6 inches per ASTM C 143. Any damage to the slurry cutoff wall as a result of operating equipment near the wall or for other reasons shall be repaired or restored by the Contractor at no additional cost to the California State University Research Foundation.

10.3 Placement: The backfill material shall be placed in the excavated trench in such a manner that no pockets of slurry are trapped in the completed slurry trench. The Contractor shall backfill continuously from the beginning of the trench in the direction of the excavation to the end of the trench. Placing operations shall proceed in such a fashion that the top of the backfill below the surface of the slurry shall follow a reasonably smooth grade and shall not have hollows which may trap pockets of slurry during subsequent backfilling. To this end, the face of the backfill below the surface of the slurry may require rodding, and the Contractor shall have such equipment available at the job site. Free dropping of backfill material through the slurry will not be permitted. Initial backfill shall be placed by lowering it to the bottom of the trench with crane and clamshell bucket until the surface of the backfill rises above the surface of the slurry trench at the end of the trench. Backfill shall then be placed in such a manner that the backfill enters the trench by sliding down the forward face of the previously placed backfill. To accomplish this, the Contractor shall backfill from the initial backfill toward the opposite end of the trench. Backfilling operations shall proceed in such a manner that the slope of the initial backfill will be maintained. The new backfill material will be allowed to slide down the slope of the previously placed backfill and shall be placed in such a manner that pockets of slurry will not be trapped during the backfilling. This remaining backfill may be accomplished by the use of bulldozer or other approved equipment and in such a manner that the backfill below the slurry surface will be pushed along the trench.

10.4 Mixing and Placing During Cold Weather: No mixing or placing of the backfill shall be performed when the air temperature is below 32 degrees F. Frozen backfill shall not be placed in the slurry trench.

11. **SLURRY CUTOFF WALL CAP**: The slurry cutoff wall cap shall have compacted fill material placed to the lines and grades shown on the drawings. After the cutoff wall has been topped off and the slurry has set, but before drying can occur, the cutoff wall shall be capped with compacted fill in accordance

with the details shown on the drawings. Any settlement of compacted fill over the cutoff wall shall be backfilled with compacted fill. The cutoff wall cap material shall classify as a (CL), (CL-ML) or a (SC) or (SM) with a minimum of 20 % fines content. The material shall be compacted to a dry density of at least 95 percent of maximum density and at a moisture content within 2 percent of the optimum moisture content. At least one compaction test (ASTM D 698), one field density test (ASTM 1556), and one soil classification test (ASTM D 2487 and ASTM D 4318) shall be performed for each 1,000 lineal feet of slurry wall cap. After the compacted fill has been properly placed and compacted at the top of the slurry cutoff wall, the levee crown shall be restored in accordance with SECTION: "AGGREGATE BASE COURSE" and where required on the drawings, SECTION: "BITUMINOUS COURSE."

12. **CLEANUP:** The Contractor shall continually clean up slurry wastes, debris and leftover materials resulting from the cutoff wall construction process. After completion of the work, the site shall be cleared of all debris which may have accumulated in the execution of the work. The Contractor shall be responsible for disposal of waste materials in accordance with all Federal, State, and local regulations and codes, such as the Clean Water Act and the National Historic Preservation Act.

13. **DISPOSAL OF WASTE MATERIALS:** Spoil generated by the cutoff wall construction shall become the property of the Contractor and shall be disposed of off-site, in accordance with all State, Federal and local regulations and codes, such as the Clean Water Act and the National Historic Preservation Act.

14. QUALITY CONTROL TESTING: The Contractor shall be responsible for project quality control records. Observation, measurements, and tests described in these specifications shall be performed for quality control. All quality control records, routine testing procedures, observations, and measurements shall be available for inspection by the California State University Research Foundation Representative's Representative at any time.

14.1 Bentonite: The Contractor shall submit in accordance with Section 01305 (Submittal Procedures), a certificate of compliance with the specifications from the bentonite supplier for each truck load of bentonite delivered to the site. The bentonite shall be tested in accordance with Section 4 of API SPEC 13A to confirm conformance with the physical requirements listed in Table 4.1 of Section 4.

14.2 Water: This section not used.

14.3 Slurry Properties: All tests specified in this paragraph shall be conducted in accordance with API RP 13B-1. The bentonite slurry shall be tested prior to placing the slurry in the trench a minimum of 2 times each working day. The following tests shall be performed: viscosity, filtration, and density. At the time of placing backfill into the slurry-filled trench, the bentonite slurry within the trench shall be tested for viscosity, filtration, and density. The bentonite slurry in the trench shall be sampled a minimum of 2 times each working day, 1 each at a depth of 10 feet and 20 feet, both within 50 feet of the advancing toe of the fill and a third sample taken within 5 feet of the toe of the backfill. The sampling devices used to collect samples will be subject to approval of the California State University Research Foundation Representative. The Contractor shall be required to obtain additional samples for the California State University Research Foundation Representative at any time or location requested. Personnel shall be provided by the Contractor for conducting the tests and they must have a working knowledge of test procedures for drilling fluids in accordance with applicable API standard procedures. Equipment for bentonite slurry testing shall be furnished and maintained by the Contractor.

14.4 Cutoff Wall Measurements: Prior to backfill operations and for every 10 feet along the cutoff wall centerline, the Contractor shall profile the entire depth of trench excavation using devices approved by the California State University Research Foundation Representative to ensure the minimum width of wall is placed during the backfilling operation.

14.5 Backfill Slope: Upon request of the California State University Research Foundation Representative, the backfill slope shall be determined by sounding the depth of the wall at horizontal intervals of 10 feet.

14.6 Soil Gradation: A representative sample of the soil being used in the backfill shall be taken every 300 lineal feet of trench and a complete soil classification performed in accordance with requirements of ASTM D422. These tests will be the responsibility of the Research Foundation.

14.7 Slump Tests: The slump of the backfill shall be tested in accordance with ASTM C 143. Slump cone tests shall be performed at equally spaced intervals throughout each construction day that backfill is being placed.

14.8 **Backfill Mix Proportions:** Backfill samples shall be collected and tested for every 300 feet of wall or when mixing operations change.. Records of the backfill mix proportions shall be maintained by the Contractor. These records shall be made of the percent by water, dry weight of the soil, bentonite, cement, and any other approved additives utilized. Any approved adjustments in the bentonite mix shall also be recorded.

15. **RECORDS:** Records shall be maintained by the Contractor for all testing, measurements, and inspections performed to ascertain that the cutoff wall construction meets the specifications. Required reports, records, and documentation shall be furnished to the California State University Research Foundation Representative daily. The Contractor's required records are outlined below.

15.1 **As-Built Profile:** An as-built profile of the trench bottom, backfill slope including descriptions of materials encountered in the trench bottom shall be continuously maintained by the Contractor. This profile shall indicate extent of excavation and the backfill profile at the end of each work day, as determined from the soundings. The Contractor shall furnish records of all observations, measurements, and tests performed, identified with the location and time of testing. These records shall be furnished no later than 24 hours after the tests, measurements, and/or observations were made.

15.2 **Results:** The results of all construction control testing required in these specifications, including water tests, slurry tests, backfill tests, and depth of soundings shall be furnished by the Contractor. The Contractor shall furnish records of all observations, measurements, and tests performed, identified with the location and time of testing. These records shall be furnished no later than 24 hours after the tests, measurements, and/or observations were made.

15.3 **Construction Log:** The Contractor shall maintain a construction log of daily activities which shall include delays encountered during construction, causes of delays, locations of affected areas, and extent of delays. The log shall also record unusual conditions or problems encountered, and the dispositions made. The Construction log is to be submitted to the California State University Research Foundation Representative at the end of each shift.

16. **QUALITY ASSURANCE:** The California State University Research Foundation may collect and perform quality assurance testing on the bentonite slurry and slurry wall backfill materials. The California State University Research Foundation testing will in no way relieve the Contractor of the responsibility of performing tests necessary to meet the construction requirements. All routine testing procedures being conducted by the Contractor shall be available for inspection by the California State University Research Foundation Representative at any time.

17. **MEASUREMENT:** Measurement for Slurry Cutoff Wall, shall be based on the area in square feet of wall measured in a vertical plane through the centerline of the slurry cutoff wall within the boundaries established by the working surface as defined in DEFINITIONS, the bottom of the slurry cutoff wall and vertical lines at each end of the slurry cutoff wall. Measurement shall be based on surveys and measurements taken at the site as directed and approved by the California State University Research Foundation Representative. Payment shall be made on the basis of a

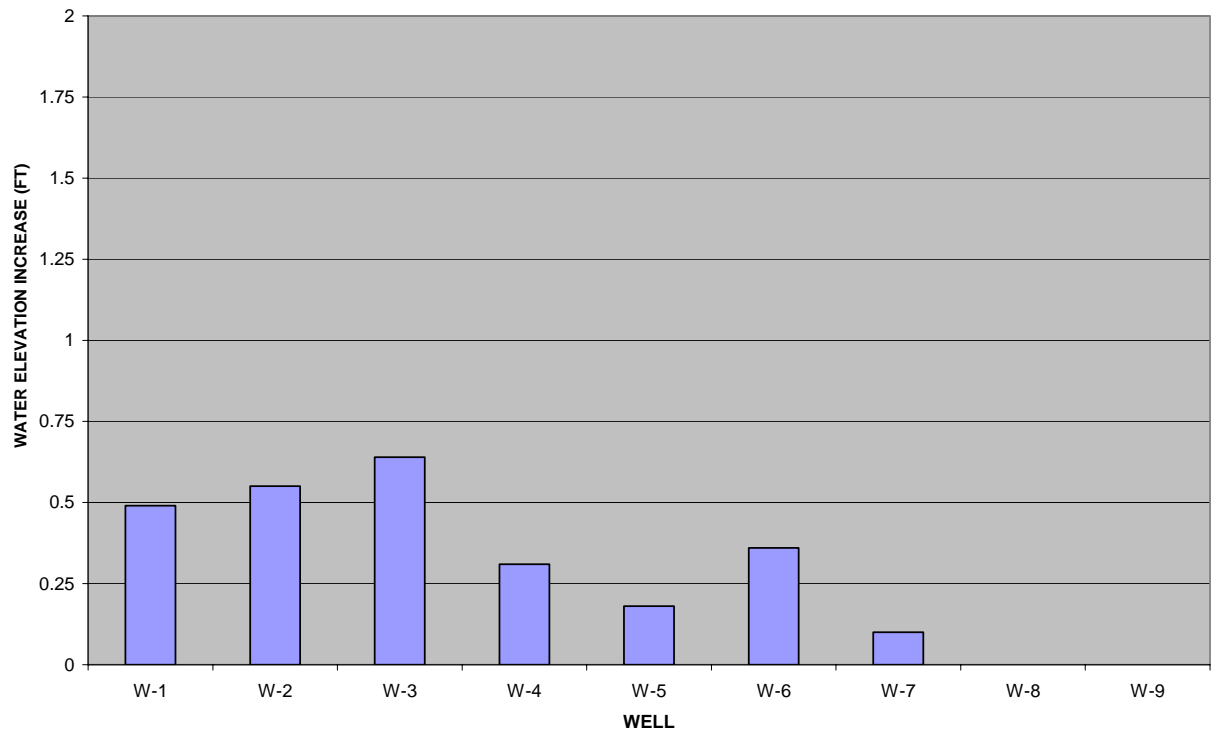
slurry wall constructed to the depth indicated on the drawings unless excavation to a greater depth is directed by the California State University Research Foundation Representative.

18. **PAYMENT:** Payment for slurry cutoff wall measured as specified herein before shall be made at the contract price per square foot. Such price shall include all costs of levee preparation, slurry cutoff wall installation, stockpiling or spoiling materials generated during the slurry cutoff wall installation, obtaining backfill materials from commercial sources, mixing, blending, placing the slurry cutoff wall backfill and slurry cutoff wall cap, and all other items incidental to the construction of the construction and completion of the slurry cutoff wall. No separate payment will be made for materials including bentonite, cement, additives, soil, equipment and mixing, handling and cleaning the slurry, diking around the open trench, and overtime during continuous operations, cleanup, assistance in the collection and maintenance of records and quality control testing; such items being included in the price of the slurry cutoff wall. Final acceptance of the slurry cutoff wall will be based on meeting all the requirements for the slurry wall dimensions, bentonite slurry mix, and the approved mix design or any California State University Research Foundation Representative approved modifications to the backfill mix design.

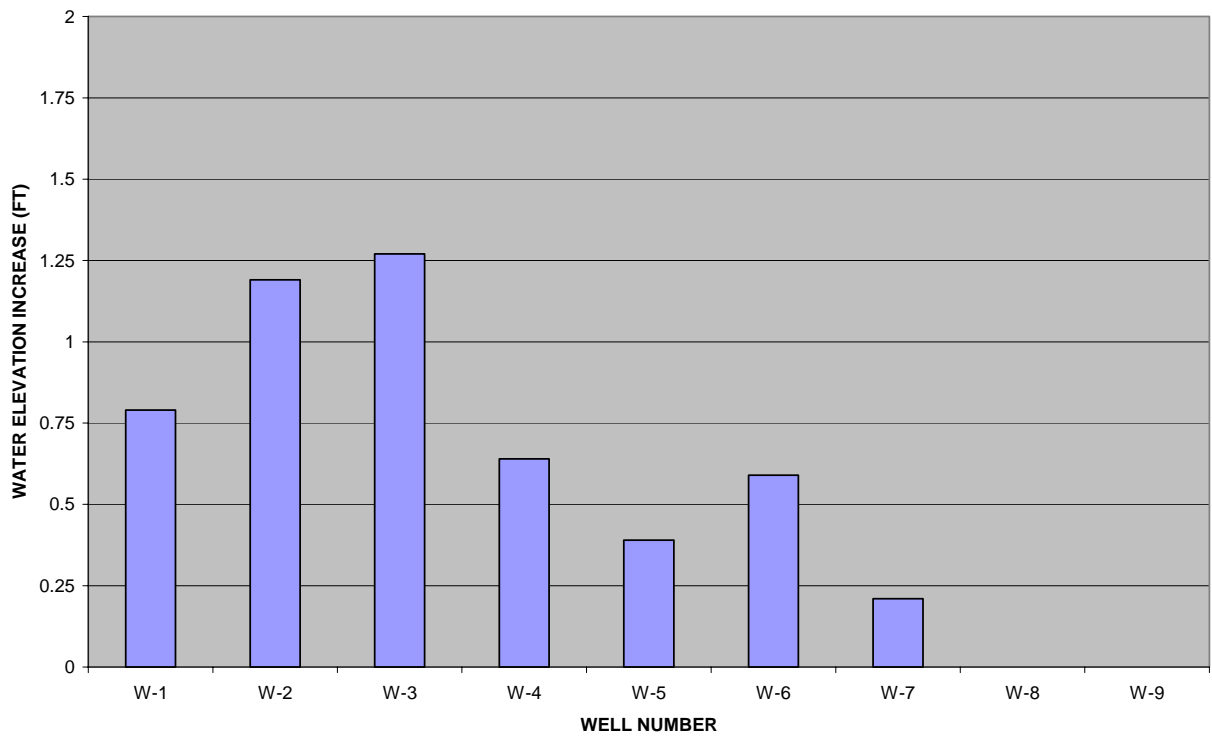
Appendix C

Monitoring Water Level Charts

6 HOURS AFTER FILLING CANAL



12 HOURS AFTER FILLING CANAL



24 HOURS AFTER FILLING CANAL

